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Description

This invention relates to sealing means for the prevention of fluid leakage between the rotating and stationary members of centrifugal fluid pumps, turbines, agitators and the like.

Conventionally, most centrifugal pumps prevent or control fluid leakage, both during operation and while stationary, by the use of interfacial seals. These seals contain stationary and rotating sealing surfaces which are held in sliding contact with a controlled surface pressure to minimise fluid leakage past the sealing surfaces. Interfacial seals may be subdivided into two classes dependent upon the disposition of the sealing surfaces relative to the rotating shaft axis, viz. axial seals and radial seals. Both types of seals are widely used in centrifugal fluid pumps.

Axial seals encompass the broad class of mechanical end face seals in which the sealing surfaces are flat, rigid, and disposed normally to the shaft axis. These seals have been widely applied to centrifugal pump, turbine and agitator shaft sealing applications with gas, liquid and slurries as the pumped product, and have been developed in an extensive range of variant designs.

Radial seals define the class of shaft seals in which the sealing contact surface is cylindrical and concentric with the pump shaft axis. The stuffing box is a commonly used seal of this type in which impermeable and compliant packing material is contained and pressurised in an annular cavity surrounding the shaft by an axially adjusted gland member. This type of seal is extensively applied in both liquid and slurry centrifugal pumps. Seals of this type belong to the class of radial seals.

The abrasive nature of pumped fluid in centrifugal slurry pumps commonly results in severe wear of shaft seal elements resulting in increased fluid leakage and maintenance requirements. Even with clean liquid pumps, sealing elements wear and require adjustment. These problems have resulted in the development of hydrodynamic shaft seals which are incorporated in many centrifugal slurry pumps. These invariably comprise auxiliary pumping vanes on the impeller which develop a hydrodynamic fluid pressure to eliminate leakage from the pump casing. During pump operation fluid leakage is eliminated or substantially reduced with this type of non contacting seal. Supplementary sealing means are required additional to the hydrodynamic seal to prevent leakage from the pump when stationary. Such static seals are commonly interfacial seals of the radial type. Although fluid leakage, in operation, is effectively prevented or controlled by the hydrodynamic seal, the continuous sliding contact at the static seal surfaces results in abrasive wear at these surfaces with resultant loss of static sealing performance.

The aim of this invention is to overcome, by novel means, a number of limitations associated with conventional centrifugal fluid pump seals and to improve current sealing technology, particularly in relation to, but not limited to, centrifugal slurry pumps (where abrasive wear is greatest), and in accordance with the following objectives:

(a) to increase the effective operating life of pump seals between maintenance overhauls;

(b) to reduce abrasive wear rate at the sealing surfaces;

(c) to provide a seal suitable for use under the most adverse fluid conditions, including heterogeneous fluids typical of coarse abrasive slurries;

(d) to permit substantial axial displacement between the stationary and rotating sealing surfaces; and

(d) to provide a seal with automatic loading of sealing surfaces and requiring no manual adjustments of loading either during installation or in operation.

US-A-3256027 discloses a sealing assembly where the sealing surface, due to a centrifugal force, disengages from the stationary member, thereby reducing wear of the sealing components.

In one aspect the present invention provides a centrifugal sealing member for preventing leakage between a rotating member and a stationary member with an outer cylindrical surface, said sealing member comprising an outer annular support member and an inner annular engaging member, said support member to be sealingly mounted on said rotating member, with said annular engaging member to sealingly engage around the said outer cylindrical surface of the stationary member when said rotating member slows below a critical rotational speed and disengage from around the said outer cylindrical surface when the rotating member rotates faster than the critical rotational speed, to provide a running clearance between the centrifugal sealing member and the stationary member, wherefor the annular engaging member has its mass and its composite modulus of radial elasticity so proportioned that when said sealing member is mounted on the rotating member and the rotating member is rotated at any speed at or less than the critical rotation speed, the annular engaging member sealingly engages on the said outer cylindrical surface and when the rotating member is rotated above the critical speed, the said annular engaging member extends radially outwardly due to centrifugal force to provide a running clearance between the rotating centrifugal sealing member and the outer cylindrical surface of the stationary member; characterised in that:

said outer annular support member is made of

elastomeric material and has a base and a top end;

said inner annular engaging member is made of elastomeric material and extends from the base end of the annular support member in a direction radially inwardly and towards the top end of the support member, said inner elastomeric engaging member being of tapered cross section, tapering towards its free end with this thickness at any point along its length being smaller than the thickness of the outer annular support member; and

a reinforcing ring completely imbedded in said outer annular support member; whereby in use said support member can sealingly engage on said rotating member.

In another aspect the invention provides a centrifugal sealing member for preventing leakage between a rotating member and a stationary member with an outer cylindrical surface, said sealing member comprising an annular support member and an inner annular engaging member, said support member being sealingly mountable on the rotating member, with said annular engaging member in use sealingly engaging around the outer cylindrical surface of the stationary member when the rotating member slows below a critical rotational speed and disengaging from around the outer cylindrical surface when the rotating member rotates faster than the critical rotational speed, to provide a running clearance between said sealing member and the stationary member characterised in that

said annular support member has an elastomeric sheath and a helical tension spring enclosed by and in intimate driving contact with said elastomeric sheath, said helical tension spring being in substantially toroidal form to be located with its rectilinear axis of symmetry substantially collinear with the axis of the outer cylindrical surface of the stationary member, multiple ballast masses enclosed within the toroidal form of said helical tension spring adapted to be driven by and rotated with said helical tension spring, and said inner annular engaging member comprising a lip projecting from said elastomeric sheath which, in use, makes sealing contact with the outer cylindrical surface of the stationary member, said projecting lip being configured for substantial radial wear.

Preferably seals according to embodiments of the present invention are used for preventing fluid leakage through the running clearance between stationary and rotating members of centrifugal pumps and the like which incorporate hydrodynamic means for preventing such leakage until their speed of rotation decreases by some predetermined fraction of normal operating speed. The seal comprises a stationary member with an outer cylindrical surface substantially concentric with the axis of rotation of the rotating members and adapted to be engaged in sealing contact by a surrounding annular sealing member by fluid tight means. The mass and the composite modulus of radial elasticity of the annular sealing member is so proportioned that, at a rotational speed greater than that at which leakage would cease to be prevented by the said hydrodynamic means, the annular sealing member extends radially outwards due to centrifugal force sufficiently to provide a running clearance between the rotating annular sealing member and the stationary cylindrical surface.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a partial cross sectional view of a preferred embodiment of the present invention with the pump shaft stationary;

Fig. 2 illustrates another embodiment of the present invention in partial cross section with the pump shaft stationary; and

Fig. 3 is partial cross sectional view taken on line I-I of Fig. 2.

Like parts are illustrated by like characters throughout the specification and drawings.

Fig. 1 shows one preferred embodiment of the invention in a simple form as applied to a centrifugal slurry pump. Pump impeller 1 is attached to shaft 2 which contains the pressurised fluid discharging from the periphery of rotating impeller 1. A secondary sealing impeller or expeller 3 is mounted on shaft 2 adjacent to impeller 1 and contained within a separate sealing chamber 4 formed by the external surface of casing member 5 and expeller chamber 6 which are clamped together in sealing contact. Expeller 3 contains multiple vanes 7 of substantially radial form attached to a substantially plane disc rotatably driven by shaft 2 and substantially concentric therewith. The annular sealing member 8 comprises an outer annular support member 9 and an integral engaging member 10, made of a suitable elastomeric material. A stiffening reinforcement ring 11 may be embedded in the sealing member. The sealing ring 8 engages in a fluid tight manner in the annular spigot 12 in the expeller 3.

The dimensions of the engaging means 10 and its modulus of elasticity are chosen such that at rotational speeds greater than that at which leakage would cease to be prevented by hydrodynamic means (i.e. the rotation of the expeller 3), the engaging means 10 moves under the influence of the centrifugal force out of sealing engagement with the outer cylindrical sealing surface 13, to provide a running clearance between the rotating sealing member 8 and the cylindrical sealing surface 13.

The main elements of the hydrodynamic sealing means in the embodiment shown in Fig. 1

comprise the vanes 7 of expeller 3 and auxiliary leakage vanes 14 of impeller 1 operating in concert with the adjacent surfaces of casing 5, expeller chamber 6, and stationary spoiler vanes 15.

The principal elements of the seal, formed by utilising the sealing member of the present invention, of which one embodiment is shown in Fig. 1, comprise the annular sealing member 8, expeller 3, and stationary member 16.

It is clear from Figure 1 that the outer annular support member has a base and a top. The inner annular engaging member is made of elastomeric material and extends from the base end of the annular support member in a direction radially inwardly and towards the top end of the support member, said inner elastomeric engaging member being of tapered cross section, tapering towards its free end with its thickness at any point along its length being smaller than the thickness of the outer annular support member (9). Further, it can be appreciated that in use, the outward radial extension due to centrifugal force on the annular engaging member is limited by contact with opposing surrounding surfaces on the rotating member so as to provide a predetermined minimum running clearance between the annular engaging member and the outer cylindrical surface of the stationary member.

Another embodiment of the sealing member is shown in Figs. 2 and 3. With reference to Fig. 2, the rotating sleeve 17 is mounted on shaft 2 adjacent and in driving contact with expeller 3. Stationary member 16 is mounted with sealing engagement in expeller chamber 6 with its outer cylindrical sealing surface 14 concentric with the axis of shaft 2. The annular sealing member 8 is the principal component of the seal, and comprises a helical tension spring 18 disposed in toroidal form with its rectilinear axis of symmetry collinear with the axis of shaft 2 and enclosed by and in intimate driving contact with an elastomeric sheath on annular engaging member 19, separate multiple ballast weights 20 mounted with working radial clearance within the toroidal core of spring 18, and a helical tension spring 21 disposed in toroidal form and moulded within an annular mounting bead of elastomer 22 concentric with shaft 2. The multiple ballast weights 20 are configured to provide maximum density of the toroidal core of spring 18. They are typically constructed in high density material, and in the embodiment shown in Fig. 3 have a barrel shaped form with conical ends, and are packed with minimum radial and end clearance within the toroidal core of spring 18 to permit relative movement between the spring coils and ballast weights 20. Spring 18 contains driving means 23 to rotatably drive ballast weights 20 with annular sealing member 8. In the embodiment shown in Fig. 3, the driving means 23 is combined with a toroidal core diameter of spring 18 and provides a rotational driving surface for ballast weights 20. The mounting bead 22 is integral with elastomeric sheath 19 and displaces axially from helical tension spring 18. Mounting bead 22 engages with static sealing contact a matching grooved recess 24 in rotation sleeve member 17, which determines the axial and radial location of annular sealing member 8 relative to rotating shaft 2. Annular sealing member 8 is rotatably driven by multiple radially disposed projections 25 at its outer periphery which are integral with elastomeric sheath 19, and which engage with corresponding surfaces 26 of vanes 7 of expeller 3.

At its inner radial extremity, and displaced axially remote from mounting bead 22, annular sealing member 8 incorporates a radial inward projection of elastomeric sheath 19 to form a continuous sealing lip 27 of limited axial width, concentric with shaft 2, and having an inner cylindrical sealing surface 28 in radial sealing contact with outer cylindrical surface 13 of stationary member 16. The geometry of seal lip 27 is configured to provide for substantial radial wear without detriment to sealing performance by initially having a smaller internal diameter (when not outwardly extended) less than the outer diameter before wear of the cylindrical surface (13). Sealing lip 27 may typically comprise a harder grade of elastomer than the elastomeric sheath 19, to which it is integrally formed, to provide more favourable wear characteristics. With pump shaft 2 stationary, the outer periphery of the annular sealing member 8 has a small radial clearance, with the inner radial extremity 29 of vanes 7 of expeller 3.

The principal elements of the seal, formed by utilizing the sealing member of the present invention, of which one embodiment is shown in Fig. 2, comprise the annular sealing member 8, rotating sleeve 17, expeller 3, and stationary member 16.

Operation of the pump seal will be described with reference to Figs. 1, 2 and 3. Effective sealing against fluid leakage is required for the two conditions of stationary and rotating shaft systems. With shaft 2 stationary, and in the low speed range during pump start-up, sealing is provided wholly by the seal of this invention. In this condition sealing chamber 4 is normally flooded with fluid, immersing the outer surface of annular sealing member 8 between seal lip 27 and the outer support member 9 (in Fig. 1) or elastomer mounting bead 22 (in Fig. 2). Sealing surface 13 of stationary sleeve member 16 and annular sealing member 8 are in sealing contact with a radial pressure predetermined to exclude fluid leakage past their common contact surfaces.

The inner surface area of annular sealing mem-

ber 8 is normally exposed to the atmosphere and subject to ambient pressure. If the outer periphery of annular sealing member 8 is subjected to a fluid pressure elevated above ambient, as may occur by supercharging of the pump inlet, the increased fluid pressure acting upon annular sealing member 8 causes increased contact pressures at seal lip 27 (in Figs 1 and 2), and at mounting bead 22 (in Fig. 2 only), thereby providing increased resistance to fluid leakage.

At normal pump operating speed, and in the upper speed range during pump start-up, sealing against fluid leakage between stationary and rotating members is provided wholly by hydrodynamic effects. The combination of expeller vanes 7 and auxiliary leakage vanes 14 of impeller 1 develops a centrifugal fluid pressure in excess of the impeller discharge pressure, hence fluid leakage from casing 5 via the sealing chamber 4 is prevented. In normal seal operation an equilibrium condition is established with fluid in sealing chamber 4 driven by expeller vanes 7 in an annular vortex at the periphery of the chamber, surrounding inner zones of air on both sides of expeller 3. Annular sealing member 8 occupies a fluid free region within the annular vortex, and leakage from sealing chamber 4 across sealing faces 13 and 28 is thus prevented by hydrodynamic fluid effects. At full operating pump speed annular sealing member 8 is in its fully radially expanded position, with its outer periphery in supporting contact with surfaces 29 of expeller 3 (for embodiment shown in Fig. 2), with corresponding separation of sealing surfaces 13 and 28.

In Fig. 1, radial expansion of annular sealing lip 10 of member 8 is caused by centrifugal force acting on the mass of the lip. This radial expansion is resisted at low speeds by elastic circumferential tension in seal lip 10.

In the speed range approaching normal pump operating speeds the combined centrifugal loading predominates over the combined elastic circumferential tension, resulting in radial expansion of annular sealing member lip 27, with a corresponding radial separation of sealing surfaces 13 and 28. The critical rotational speed of annular sealing member 19 at which sealing surfaces 13 and 28 separate is an important seal design parameter, and is a function of the axial spacing relationship of seal lip 27, spring 18 and mounting bead 22; the masses of ballast weights 20, spring 18 and elastomeric sheath 19; and the radial stiffness of spring 18, seal lip 10 stiffness and mass and elastomeric sheath 19. Typically these design parameters are configured to produce separation of sealing surfaces 13 and 28 at a rotational speed lower than the lowest limit of normal pump operating speeds.

Sealing surfaces 13 and 28 are thus in sliding contact only during the brief starting and stopping process. During normal pump operation the surfaces are separated with consequent absence of abrasive wear. This is of particular relevance in centrifugal slurry pumps in which sliding surfaces are unavoidably contaminated by abrasive solid particles with resultant rapid abrasive wear. Abrasive wear at sealing surfaces 13 and 28 is limited only to the acceleration and deceleration periods during starting and shut-down of the pump during which the pump speed is below the critical seal separation speed.

It is a common feature of centrifugal slurry pumps that axial adjustment of shaft 2 and associated rotating components is normally provided to improve deteriorating pump performance resulting from increased impeller end clearances caused by abrasive wear. The present invention can tolerate large axial displacement of seal lip of the sealing member due to its cylindrical contact geometry and axial extent of the matching stationary sealing surface. Axial shaft adjustment is beneficial to seal operation with this invention as the localised worn stationary surface adjacent to the surface of annular sealing member 16 is replaced with unworn surface by axial adjustment of the shaft.

Claims

1. A centrifugal sealing member for preventing leakage between a rotating member and a stationary member with an outer cylindrical surface, said sealing member comprising an outer annular support member (9) and an inner annular engaging member (10), said support member to be sealingly mounted on said rotating member, with said annular engaging member to sealingly engage around the said outer cylindrical surface of the stationary member when said rotating member slows below a critical rotational speed and disengage from around the said outer cylindrical surface when the rotating member rotates faster than the critical rotational speed, to provide a running clearance between the centrifugal sealing member and the stationary member; characterised in that the annular engaging member (10) has its mass and its composite modulus of radial elasticity so proportioned that when said sealing member is mounted on the rotating member and the rotating member is rotated at any speed at or less than the critical rotation speed, the annular engaging member sealingly engages on the said outer cylindrical surface and when the rotating member is rotated above the critical speed, the said annular engaging member extends radially outwardly

due to centrifugal force to provide a running clearance between the rotating centrifugal sealing member and the outer cylindrical surface of the stationary member;

said outer annular support member (9) is made of elastomeric material and has a base and a top end;

said inner annular engaging member (10) is made of elastomeric material and extends from the base end of the annular support member in a direction radially inwardly and towards the top end of the support member, said inner elastomeric engaging member being of tapered cross section, tapering towards its free end with this thickness at any point along its length being smaller than the thickness of the outer annular support member (9); and

a reinforcing ring (11) completely imbedded in said outer annular support member; whereby in use said support member can sealingly engage on said rotating member.

2. A centrifugal sealing member according to claim 1 characterised in that, in use, the outward radial extension due to centrifugal force on the annular engaging member (10) is limited by contact with opposing surrounding surfaces on the rotating member so as to provide a predetermined minimum running clearance between the annular engaging member and the outer cylindrical surface of the stationary member.

3. A centrifugal sealing member for preventing leakage between a rotating member and a stationary member with an outer cylindrical surface, said sealing member comprising an annular support member (8) and an inner annular engaging member (27), said support member being sealingly mountable on the rotating member, with said annular engaging member (27) in use sealingly engaging around the outer cylindrical surface (13) of the stationary member when the rotating member slows below a critical rotational speed and disengaging from around the outer cylindrical surface when the rotating member rotates faster than the critical rotational speed, to provide a running clearance between said sealing member and the stationary member characterised in that

said annular support member (8) has an elastomeric sheath (19) to be in engagement with the rotating member in use and a helical tension spring (18) enclosed by and in intimate driving contact with said elastomeric sheath, said helical tension spring being in substantially toroidal form to be located with its rectilinear axis of symmetry substantially collinear with the axis of the outer cylindrical surface of the stationary member, multiple ballast masses (20) enclosed within the toroidal form of said helical tension spring adapted to be driven by and rotated with said helical tension spring, and said inner annular engaging member (27) comprising a lip projecting from said elastomeric sheath (19) which, in use, makes sealing contact with the outer cylindrical surface of the stationary member, said projecting lip being configured for substantial radial wear.

4. A centrifugal sealing member according to claim 3 for use with a rotating member (3) which defines a grooved recess (24), said support member (8) comprising an annular lateral extension of said elastomeric sheath terminating axially in a mounting bead (22) moulded about a toroidal helical spring (21), said bead being for engaging detachably and sealingly in the matching grooved recess (24) of the rotating member.

5. A centrifugal sealing member according to claim 3 or 4 characterised in that said elastomeric sheath (19) is provided on its outer peripheral surface with projections (25) for driving engagement with the rotating member.

6. A centrifugal seal assembly according to claim 3, 4 or 5 when in use with a rotating member (3) and a stationary member (8) with an outer cylindrical surface, wherein the internal diameter of said unworn projecting lip (27) before use and wear and when not radially outwardly extended is less than the unworn diameter of the cylindrical surface (13) of the stationary member on which it seals by an amount such that sealing engagement is maintained by the elasticity of said annular sealing member after significant wear of both said projecting lip and the cylindrical surface has occurred.

Revendications

1. Elément d'étanchéité centrifuge pour empêcher toute fuite entre un élément tournant et un élément fixe ayant une surface cylindrique externe, ledit élément d'étanchéité comprenant un élément de support annulaire externe (9) et un élément de mise en contact annulaire interne (10), ledit élément de support étant destiné à être monté de manière étanche sur ledit élément tournant, ledit élément de mise en contact annulaire étant prévu pour venir en contact de manière étanche autour de ladite surface cylindrique externe dudit élément fixe

lorsque ledit élément tournant tourne au-dessous d'une vitesse de rotation critique et étant prévu pour se séparer d'autour de ladite surface cylindrique externe lorsque l'élément tournant tourne à une vitesse supérieure à la vitesse de rotation critique, ceci afin d'assurer un jeu de fonctionnement entre l'élément d'étanchéité centrifuge et l'élément fixe ;

caractérisé en ce que l'élément de mise en contact annulaire (10) a sa masse et son module d'élasticité radiale composite proportionnés de telle sorte que lorsque ledit élément d'étanchéité est monté sur un élément tournant et que lorsque l'élément tournant est mis en rotation à une quelconque vitesse voisine ou inférieure à la vitesse de rotation critique, l'élément de mise en contact annulaire vienne en contact de manière glissante sur ladite surface cylindrique externe et que lorsque l'élément tournant est mis en rotation à une vitesse supérieure à la vitesse critique, ledit élément de mise en contact annulaire s'étende radialement à l'extérieur du fait de la force centrifuge afin d'assurer un jeu de fonctionnement entre l'élément d'étanchéité centrifuge tournant et la surface cylindrique externe de l'élément fixe ;

ledit élément de support annulaire externe (9) est réalisé en élastomère et il comporte une extrémité de base et une extrémité de sommet ;

ledit élément de mise en contact annulaire interne (10) est réalisé en élastomère et il s'étend depuis l'extrémité de base de l'élément de support annulaire suivant une direction radialement interne ainsi qu'en direction de l'extrémité de sommet de l'élément de support, ledit élément de mise en contact interne en élastomère présentant une section en coupe à parois inclinées qui diminue en direction de son extrémité libre, son épaisseur au niveau de n'importe quel point situé le long de sa longueur étant inférieure à l'épaisseur de l'élément de support annulaire externe (9) ; et

une bague de renforcement (11) complètement noyée dans ledit élément de support annulaire externe ; et ainsi, lors de son utilisation, ledit élément de support peut venir en contact de manière glissante sur ledit élément tournant.

2. Elément d'étanchéité centrifuge selon la revendication 1, caractérisé en ce que, en fonctionnement, l'extension radiale externe due à la force centrifuge qui s'exerce sur l'élément de mise en contact annulaire (10) est limitée par le contact avec des surfaces voisines opposées sur l'élément tournant de manière à assurer un jeu de fonctionnement minimal prédéterminé entre l'élément de mise en contact annulaire et la surface cylindrique externe de l'élément fixe.

3. Elément d'étanchéité centrifuge pour empêcher toute fuite entre un élément tournant et un élément fixe ayant une surface cylindrique externe, ledit élément d'étanchéité comprenant un élément de support annulaire (8) et un élément de mise en contact annulaire interne (27), ledit élément de support pouvant être monté de manière glissante sur l'élément tournant, ledit élément de mise en contact annulaire (27), lors de son utilisation, venant en contact de manière glissante autour de la surface cylindrique externe (13) de l'élément fixe lorsque l'élément tournant est mis en rotation à une vitesse inférieure à une vitesse de rotation critique et se séparant d'autour de la surface cylindrique externe lorsque l'élément tournant est mis en rotation à une vitesse supérieure à la vitesse de rotation critique, ceci afin d'assurer un jeu de fonctionnement entre ledit élément d'étanchéité et l'élément fixe, caractérisé en ce que :

ledit élément de support annulaire (8) comporte une gaine en élastomère (19) qui doit venir en contact avec l'élément tournant en fonctionnement, ainsi qu'un ressort de rappel hélicoïdal (18) contenu par ladite gaine en élastomère et en contact d'entraînement intime avec cette dite gaine, ledit ressort de rappel hélicoïdal présentant une forme sensiblement toroïdale de manière à être positionné avec son axe de symétrie rectiligne sensiblement colinéaire à l'axe de la surface cylindrique externe de l'élément fixe, de multiples masses de lest (20) étant contenues à l'intérieur de la forme toroïdale dudit ressort de rappel hélicoïdal et étant adaptées pour être entraînées par ledit ressort de rappel hélicoïdal et pour être mises en rotation avec, et ledit élément de mise en contact annulaire interne (27) comprenant une lèvre qui se projette depuis ladite gaine en élastomère (19) et qui, en fonctionnement, établit un contact d'étanchéité avec la surface cylindrique externe de l'élément fixe, ladite lèvre qui se projette étant configurée pour une usure radiale sensible.

4. Elément d'étanchéité centrifuge selon la revendication 3, destiné à une utilisation avec un élément tournant (3) qui définit un évidement en forme de gorge (24), ledit élément de support (8) comprenant une extension latérale annulaire de ladite gaine en élastomère qui se termine axialement selon une bordure de montage (22) moulée autour d'un ressort hélicoïdal

toroïdal (21), ladite bordure étant destinée à venir en contact de manière amovible et par glissement dans l'évidement en forme de gorge correspondant (24) de l'élément tournant.

5. Elément d'étanchéité centrifuge selon la revendication 3 ou 4, caractérisé en ce que ladite gaine en élastomère (19) est munie sur sa surface périphérique externe de protubérances (25) pour une mise en contact par entraînement avec l'élément tournant.

6. Assemblage d'étanchéité centrifuge selon la revendication 3, 4 ou 5, destiné à une utilisation avec un élément tournant (3) et un élément fixe (8) ayant une surface cylindrique externe, dans lequel le diamètre interne de ladite lèvre non usée se projetant (27) avant utilisation et usure et lorsqu'elle n'est pas étendue radialement vers l'extérieur est inférieur au diamètre non usé de la surface cylindrique (13) de l'élément fixe sur lequel elle établit une étanchéité d'une valeur telle que la mise en contact d'étanchéité soit maintenue par l'élasticité dudit élément d'étanchéité annulaire après qu'une usure significative à la fois de ladite lèvre se projetant et de la surface cylindrique s'est produite.

Patentansprüche

1. Zentrifugaldichtelement zum Verhindern einer Leckage zwischen einem rotierenden Element und einem stationären Element mit einer äußeren zylindrischen Oberfläche, wobei das Dichtelement ein äußeres ringförmiges Stützelement (9) und ein inneres ringförmiges Eingriffselement (10) aufweist, wobei das Stützelement dichtend auf dem rotierenden Element angeordnet ist und wobei das ringförmige Eingriffselement dichtend um die äußere zylindrische Oberfläche des stationären Elementes eingreift, wenn das rotierende Element sich unter eine kritische Drehgeschwindigkeit verlangsamt, und außer Eingriff von der äußeren zylindrischen Oberfläche gelangt, wenn das rotierende Element schneller als die kritische Drehgeschwindigkeit dreht, um ein Betriebsspiel zwischen dem Zentrifugaldichtelement und den stationären Element vorzusehen,
dadurch gekennzeichnet,
daß das Gewicht und der radiale Elastizitätsmodul des ringförmigen Eingriffselementes (10) so proportioniert sind, daß, wenn das Dichtelement auf dem rotierenden Element angeordnet ist und das rotierende Element mit irgendeiner Geschwindigkeit bei oder weniger als die kritische Drehgeschwindigkeit gedreht wird, das ringförmige Eingriffselement dichtend um die äußere zylindrische Oberfläche eingreift und daß, wenn das rotierende Element oberhalb der kritischen Drehgeschwindigkeit gedreht wird, das ringförmige Eingriffselement infolge der Zentrifugalkraft sich radial nach außen erstreckt, um ein Betriebsspiel zwischen dem rotierenden Zentrifugaldichtelement und der äußeren zylindrischen Oberfläche des stationären Elementes vorzusehen, wobei das äußere ringförmige Stützelement (9) aus elastomerem Material besteht und ein oberes und ein unteres Ende aufweist, wobei das innere ringförmige Eingriffselement (10) aus elastomerem Material besteht und sich vom unteren Ende des ringförmigen Stützelementes in einer radial einwärts gerichteten Richtung gegen das obere Ende des Stützelementes erstreckt, wobei das innere elastomere Eingriffselement einen sich verjüngenden Querschnitt aufweist, der sich zu seinem freien Ende hin verjüngt, wobei die Dicke an jedem Punkt entlang seiner Länge kleiner als die Dicke des äußeren ringförmigen Stützelementes (9) ist, und wobei ein Stützring (11) vollständig in dem äußeren ringförmigen Stützelement eingebettet ist, wobei im Gebrauch das Stützelement dichtend um das drehende Element eingreifen kann.

2. Zentrifugaldichtelement nach Anspruch 1, dadurch gekennzeichnet,
daß im Gebrauch die auswärtige Radialerstrekkung infolge der Zentrifugalkraft auf das ringförmige Eingriffselement (10) durch einen Kontakt mit gegenüberliegenden umgebenden Flächen des rotierenden Elementes begrenzt wird, um ein vorbestimmtes Minimalbetriebsspiel zwischen dem ringförmigen Eingriffselement und der äußeren zylindrischen Oberfläche des stationären Elementes vorzusehen.

3. Zentrifugaldichtelement zum Verhindern einer Leckage zwischen einem rotierenden Element und einen stationären Element mit einer äußeren zylindrischen Oberfläche, wobei das Dichtelement ein ringförmiges Stützelement (8) und ein inneres ringförmiges Eingriffselement (27) aufweist, wobei das Stützelement dichtend auf den rotierenden Element anordbar ist, wobei das ringförmige Eingriffselement (27) im Gebrauch dichtend um die äußere zylindrische Oberfläche (13) des stationären Elementes eingreift, wenn das rotierende Element sich unter eine kritische Drehgeschwindigkeit verlangsamt, und außer Eingriff gelangt von der äußeren zylindrischen Oberfläche, wenn das rotierende Element sich schneller als die kritische Drehgeschwindigkeit dreht, um ein Betriebs-

spiel zwischen dem Dichtelement und dem stationären Element vorzusehen,
dadurch gekennzeichnet,
daß das ringförmige Stützelement (8) eine elastomere Hülle (19), die im Gebrauch in Eingriff mit dem rotierenden Element ist, und eine Schraubenspannfeder (18) aufweist, die von der elastomeren Hülle umschlossen und mit dieser in engem Antriebskontakt ist, wobei die Schraubenspannfeder im wesentlichen eine ringförmige Form aufweist, um mit ihrer geradlinigen Symmetrieachse im wesentlichen colinear mit der Achse der äußeren zylindrischen Oberfläche des stationären Elementes angeordnet zu sein, wobei mehrere Ballastmassen (20) innerhalb der ringförmigen Form der Schraubenspannfeder eingeschlossen sind, um von der Schraubenspannfeder angetrieben und mit dieser gedreht zu werden, und wobei das innere ringförmige Eingriffselement (27) eine von der elastomeren Hülle (19) vorstehende Nase aufweist, die im Gebrauch einen dichtenden Kontakt mit der äußeren zylindrischen Oberfläche des stationären Elementes herstellt, wobei die vorstehende Nase für einen wesentlichen radialen Abrieb ausgebildet ist.

4. Zentrifugaldichtelement nach Anspruch 3 zur Verwendung mit einem rotierenden Element (3), welches eine Ausnehmung (24) definiert, wobei das Stützelement (8) eine ringförmige seitliche Ausdehnung der elastomeren Hülle aufweist, die axial in einen Montagerandwulst (22) um eine ringförmige Schraubenfeder (21) endet, wobei die Wulst zum entnehmbaren und dichtenden Eingriff in der Gegenausnehmung (24) des rotierenden Elementes dient.

5. Zentrifugaldichtelement nach Anspruch 3 oder 4,
dadurch gekennzeichnet,
daß die elastomere Hülle (19) auf ihrer äußeren Umfangsfläche mit Vorsprüngen (25) zum Antriebseingriff mit dem rotierenden Element versehen ist.

6. Zentrifugaldichtanordnung nach Anspruch 3, 4 oder 5 zur Verwendung mit einem rotierenden Element (3) und einem stationären Element (8) mit einer äußeren zylindrischen Oberfläche, wobei der innere Durchmesser der nicht abgenutzten vorstehenden Nase (27) vor Gebrauch und Abnutzung und ohne radiale Richtung nach außen geringer als der nicht abgenutzte Durchmesser der zylindrischen Oberfläche (13) des stationären Elementes ist, auf welcher diese mit einem Maße dichtet, daß der dichtende Eingriff durch die Elastizität des ringförmigen Dichtelementes nach einer signifikanten Abnutzung der vorstehenden Nase und der zylindrischen Fläche aufrechterhalten wird.

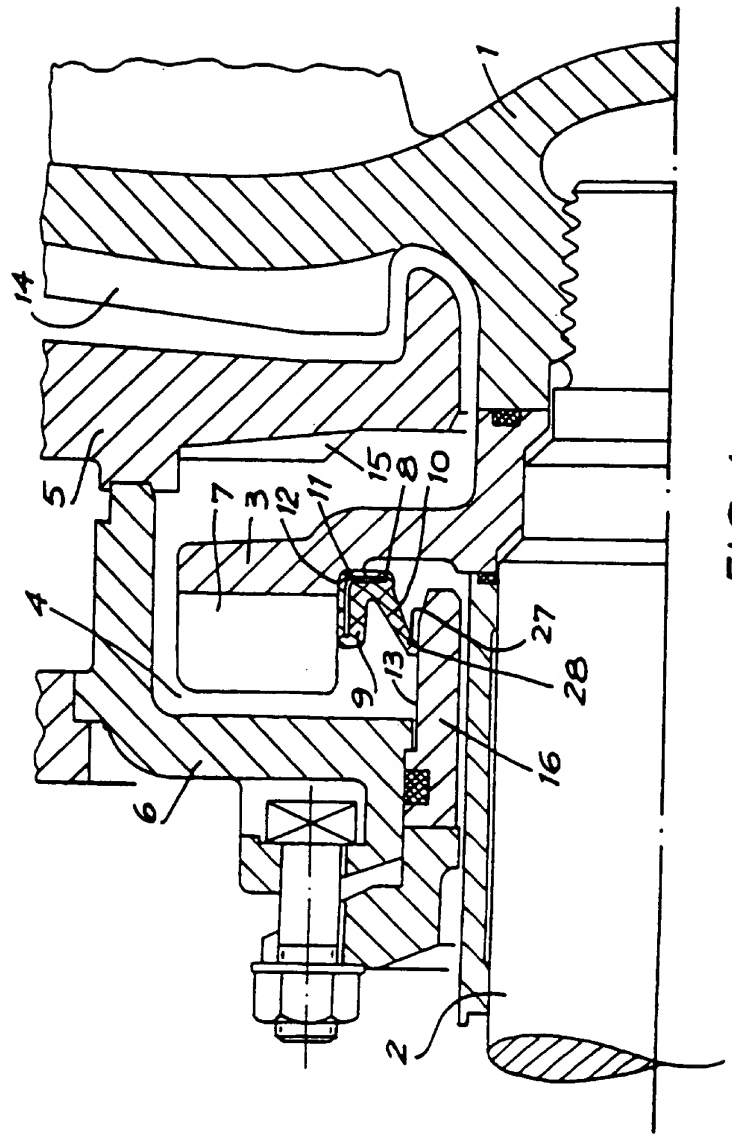

FIG.1

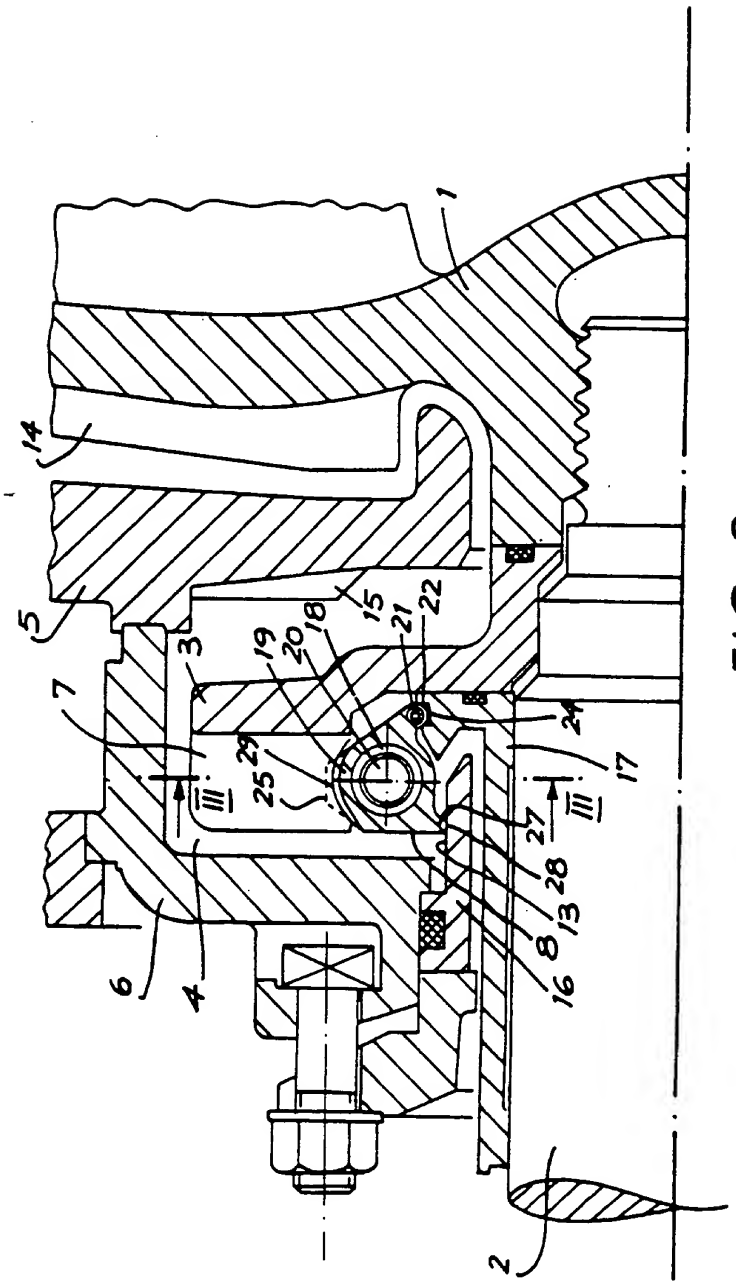

FIG. 2

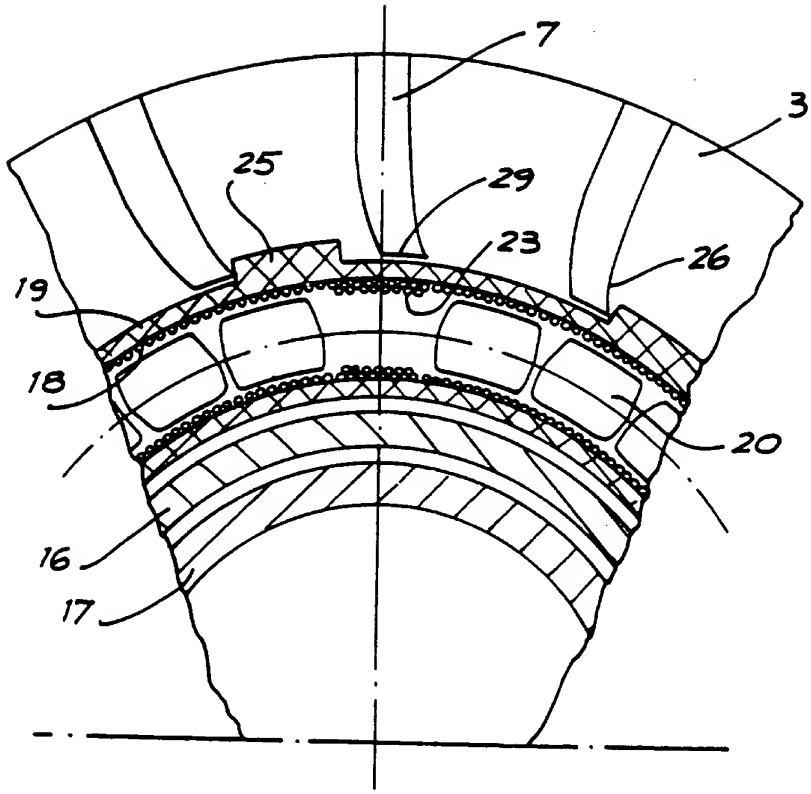

FIG. 3